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Abstract

Consider a principal who sets a budget that the agent allocates among different services. Because the preferences of the agent may differ from those of the principal, the budget the principal sets can be lower or higher than in the first-best solution. When the principal is uncertain about the agent's preferences, the agent may choose an allocation that signals his type, thereby affecting the size of the budget the principal will set in the following period. The equilibrium may have separation or pooling. In a pooling equilibrium, the agent may mis-represent his preferences, aiming to get a large budget in the future period.

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1 Introduction

Government often has one person or group set a budget, and another group or person decide how to allocate that budget across different services. We can think of Congress allocating a budget to the Federal Aviation Administration, with the Administration deciding where to allocate air traffic personnel, how many hours each facility should be open, and so on. A state legislature may give a budget to a state university, with the university deciding how many faculty to hire in the humanities, how many in the social sciences, and so on. Or, a central government may transfer funds to a local government, with the local government deciding how to spend the budget. Such situations are examples of principal-agent situations, where the principal sets the budget, and the agent chooses how to spend the budget.

Problems with such delegation arise when the principal's preferences differ from the agent's. The first issue we address is whether the principal will give a budget larger or smaller than he would if the agent's preferences were the same as the principal's. The answer is not obvious. The principal may want to give a small budget because he fears that the agent will spend the money in ways the principal dislikes. But the opposite effect may arise if the principal worries that the agent will spend little on the service the principal favors; to assure provision of that service the principal may have to give a large budget.

The second issue this chapter addresses is strategic behavior by the agent. The agent, who allocates any budget given him across the different services, prefers a large budget. If the principal is unsure of the agent's type, then the agent in one period may allocate the budget in a way that would induce the principal to give a large budget in the next period.

We also examine the Japanese fiscal problem, focusing on public works. The Ministry of Finance can be viewed as the principal, and the spending ministry as the agent. The spending ministry may be pressured by local governments or by local interests, and may have underestimated the costs of local public works with the aim of increasing the budget the Ministry of Finance provides. Consequently, some public projects including roads, bridges, and airports may be inefficient.

2 Literature

2.1 Reputation

One issue we shall address is how an agent may take action which affects the principal's beliefs about the agent's type. A large literature examines behavior intended to affect reputation, with the principal often viewed as voters, and the agent as an elected official. Reputational concerns may lead a politician to terminate a policy that he, but not the voters, knows has failed (Beniers and Dur 2007). And reputational concerns can give rise to political correctness: an adviser who wishes to avoid a reputation for bias may not truthfully reveal his information (Morris 2001). A career-concern model where the incumbent attempts to signal ability is analyzed by Canes-Wrone, Herron, and Shotts (2001). Our assumptions resemble those in Fox (2007), who shows that an agent who

cares about his reputation may adopt policies commonly associated with a high-quality agent, though the state of nature would call for a different policy. He further shows that if an agent can hide his actions from the public, this distortion can be reduced. Relatedly, Prat (2005) shows that a career-driven agent who knows that his action is observed has an incentive to conform. The principal is damaged by such behavior, and may want to commit to keep the agent's action secret. Carpenter (2004) uses a career-concerns model to argue that the U.S. Food and Drug Administration may delay approving some drugs because it wants to safeguard its reputation for protecting the public's health.

An incumbent may increase his chances of winning election by pandering to the public, taking actions the public may incorrectly believe are best (Maskin and Tirole 2004, and Smart and Sturm 2013). If a project will likely fail even under a skilled leader, a leader (whether skilled or not) may prefer projects likely to fail over projects likely to succeed (Majumdar and Mukand 2004). Indeed, a politician with a bad reputation may favor a highly risky policy—if the policy fails, he would have lost the next election anyway, but if the policy succeeds, his reputation and so his chances of re-election improve. This idea is applied by Hess and Orphanides (1995) to claim that a president with a bad reputation who goes to war gets an opportunity to improve his reputation. Relatedly, if voters learn about a politician's ability from the performance of a new project he undertakes, then an incumbent ignorant of his own ability will adopt too many projects if he is at risk of losing re-election; he will adopt too few projects if he is likely to win re-election (Biglaiser and Mezzetti 1997).

Kessler (2010) considers a model in which local government officials with private information about the benefits of a policy have an incentive, when engaging in cheap talk, to hide that information from the central government. The imperfect information held by the central government can generate overspending, universalism, and uniformity.

Most of that literature has a bad type want to mimic a good type. In our model, a good type may want to mimic a bad type, because that can increase the budget.

The strategic behavior of agents we examine relates to the ratchet effect, which considers a worker who may exert little effort today: he anticipates that the employer may infer that high effort signals a low cost of effort, inducing the employer to offer a lower wage in the future. For example, in Lazear (1986) and Gibbons (1987) the worker has private information about the firm (such as the job's difficulty), which he is reluctant to reveal. In Aron (1987) and in Kanemoto and MacLeod (1992) the worker has private information about a worker-specific attribute, such as ability.

2.2 Preferences of agents

The agent's preferences may differ from the principal's because the agent is corrupt, or influenced by special interest groups. The differences can also appear when the agent is intrinsically motivated, caring about policy or outcomes, rather than only about the income he earns. Work in the public administration literature provides evidence of intrinsic motivation among public-sector employees (Guyot 1962, and Crewson, 1997). Other work investigates whether individuals with higher levels of intrinsic motivation are more often found in the public sector. For example, Gregg et al. (2011) use British

survey data to investigate whether prosocial behavior (as measured by the probability of working extra, unpaid, hours) is more prevalent in the nonprofit than in the for-profit sector. These authors find that individuals in the nonprofit sector are significantly more likely to work such extra hours. Survey data studied by Georgellis, Iossa, and Tabvuma (2011) also support the hypothesis that individuals are attracted to the public sector more by intrinsic than extrinsic rewards.[1]

2.3 Competition among agents

Our consideration of a principal allocating money among agents relates to work on the Good Samaritan Dilemma, where an altruist donor gives more money to a recipient the poorer is that recipient (Buchanan 1977). The Rotten Kid Theorem states that if all potential recipients get transfers from an altruist, then under some (but not all) conditions the potential recipients, even if selfish, gain from maximizing the joint income of donors and recipients (Becker 1974).

2.4 The budget process in Japan

Earlier work has considered the budgetary process in Japan and has proposed reforms that would improve fiscal discipline. Sato (2002) describes negotiations between the Ministry of Finance and the ministry in charge of providing grants to local governments; he shows that the equilibrium has the Ministry of Finance give a large budget to the spending ministry, anticipating its subsequent behavior. Tanaka (2011) presents international comparative studies on fiscal reforms. None of these analyses, however, deal with asymmetric information between the principal and the agent.

Akai (2014) and Ihori (2014) emphasize that the government should commit not to accommodate *ex post* fiscal needs. On the other hand, Besfamille and Lockwood (2008) show that a hard budget constraint may not be always optimal. This chapter studies difficulties government faces when it cannot commit, and shows that strict fiscal restraints may give rise to manipulation of information by the agent who expects a large budget in the future.

3 Agent provides only one of the two services

We begin with a simple model with an agent who provides only one of two services. The agent's utility in any period is

$$\alpha_A v_A(x_1) + (1-\alpha_A) v_A(x_2), \tag{1}$$

where α_A captures the agent's preferences for service 1 relative to service 2; $x_1(\geq 0)$ and $x_2(\geq 0)$ are the quantities of services 1 and 2. Assume that $v_i' > 0$, $v_i'' < 0$, and that $v_i(0) = 0$. Let $\alpha_A = 1$ or else $\alpha_A = 0$. Thus, the agent would want to spend all his budget on either service 1 alone, or else on service 2 alone.

[1] For a selective review of research on the existence and the effects of prosocial behavior among individuals working in public organizations, see Polidori and Teobaldelli (2013).

The principal gives the agent a budget $\bar{X} \geq 0$. The principal's utility in any period is

$$\alpha_P v_P(x_1) + (1-\alpha_P) v_P(x_2) - \bar{X}, \tag{2}$$

where again $\alpha_P = 1$ or else $\alpha_P = 0$. We assume in this section that $\alpha_P = 1$; that is, the principal prefers service 1 to service 2.

Consider first outcomes under perfect information. If the principal knew that the agent also had $\alpha_A = 1$, then the principal would give the agent a budget $\bar{X}^P$ satisfying $v_P'(\bar{X}^P) = 1$, and the agent would spend all that budget on service 1. If the principal knew that the agent had $\alpha_A = 0$, then the principal would choose $\bar{X} = 0$, fearing that the agent would spend all the budget given to him on policy 2. Even if this stage game in each period is repeated for multiple periods, the principal and the agent will behave the same way in each period.

But now suppose that the principal does not know whether $\alpha_A = 1$ (type 1) or $\alpha_A = 0$ (type 2). The principal sets a budget $\bar{X}_t$ in period t. The timing of the game is as follows. In period 1:

1. Nature determines α_A.
2. The principal sets the budget $\bar{X}_1$.
3. The agent allocates the budget between the two services as (x_{11}, x_{12}).

In period 2:

1. The principal updates his beliefs about the agent's type.
2. The principal sets a new budget $\bar{X}_2$.
3. The agent allocates the budget between the two services as (x_{21}, x_{22}).

Two cases must be distinguished. In a separating equilibrium, in period 1 the agent allocates the budget in a way that reveals his type. Then in period 2 the principal sets $\bar{X}_2 = 0$ if the agent values service 2, and the principal sets $\bar{X}_2 = \bar{X}^P$ to satisfy $v_P'(\bar{X}_2) = 1$ if the agent values service 1.

In a pooling equilibrium the agent in period 1 spends all his budget on service 1, even if he values service 2 (we shall suppose that if the agent spends anything at all on service 2, even if not all the budget, then the principal believes that the agent has $\alpha_A = 0$, or that the agent values only service 2). The principal in period 2 then does not know the agent's type. Let the prior probability that the agent has $\alpha_A = 1$ be π_1, with $0 < \pi_1 < 1$. Then the principal's expected utility is

$$-\bar{X}_2 + \pi_1 v_P(\bar{X}_2). \tag{3}$$

In period 2 the principal will set $\bar{X}_2 = \bar{X}^\pi$ to satisfy $v_P'(\bar{X}_2) = \frac{1}{\pi_1}$. Thus, in the pooling equilibrium the principal is uncertain about the agent's type; in a separating equilibrium, the principal is certain about the agent's type, and in period 2 he gives the budget such that $\bar{X}_2 = \bar{X}^P$ for type 1 and $\bar{X}_2 = 0$ for type 2. Note that $0 < \bar{X}^\pi < \bar{X}^P$.

We can determine the value $\bar{X}_1$ that will induce a separating rather than a pooling equilibrium. A type-2 agent (that is an agent who values only service 2) will reveal his own type if

$$v_A(0) + v_A(\bar{X}^P) \leq v_A(\bar{X}_1) + v_A(0), \tag{4}$$

or if $v_A(\bar{X}_1) \geq v_A(\bar{X}^P)$. That is, inducing truthful revelation (instead of pooling) requires that the budget allocation in period 1 be large. The budget allocation is costly to the principal, so that he will choose $\bar{X}_1 = \bar{X}^P$.

On the other hand, a type-2 agent will want to mimic a type-1 agent if

$$v_A(0) + v_A(\bar{X}^\pi) \geq v_A(\bar{X}_1) + v_A(0), \tag{5}$$

or if $v_A(\bar{X}_1) \leq v_A(\bar{X}^\pi)$. Thus, the principal does not need to set a large budget to induce a pooling equilibrium, so that he chooses $\bar{X}_1 = \bar{X}^\pi$.

Will the principal prefer full revelation to a pooling equilibrium? If he gives a small budget in period 1, $\bar{X}^\pi$, inducing a pooling equilibrium, then the principal's expected utility over two periods is

$$v_P(\bar{X}^\pi) - \bar{X}^\pi + \pi_1 v_P(\bar{X}^\pi) - \bar{X}^\pi. \tag{6}$$

If in period 1 the principal allocates $\bar{X}^P$, inducing a separating equilibrium, his expected utility is

$$\pi_1 v_P(\bar{X}^P) - \bar{X}^P + \pi_1[v_P(\bar{X}^P) - \bar{X}^P]. \tag{7}$$

Note that

$$\pi_1 v_P(\bar{X}^\pi) - \bar{X}^\pi < \pi_1[v_P(\bar{X}^\pi) - \bar{X}^\pi] < \pi_1[v_P(\bar{X}^P) - \bar{X}^P]. \tag{8}$$

Because the principal can then set the optimal budget for each type in period 2, his utility in period 2 is greater in the separating equilibrium than in the pooling equilibrium. We cannot, however, determine whether utility in period 1 is higher in (6) than in (7).

Another possibility is that the principal hides his type. If the agent thinks that the principal is equally likely to value the two services, then the agent will spend his budget in period 1 on the good the agent values, thereby revealing his type. Note that with many agents there is a higher probability that at least one of the agents has the same preferences as the principal does. That higher probability reduces the incentive to mimic the principal's type.

4 Agent provides two services

This section extends the model to have the principal and the agent value both services rather than only one or the other. The principal sets the budget, and the agent allocates it between two services. The utility function of the agent or of the principal is

$$\alpha_j v(x_1) + (1 - \alpha_j) v(x_2) + m_j, \tag{9}$$

where $0 < \alpha_j < 1$, $j = P, A$, and m_j is private consumption. The principal and the agent are assumed to have the same function v.

The principal is endowed with $\bar{Y}$. When he delegates the allocation of the budget between services to the agent, his private consumption is

$$m_P = \bar{Y} - \bar{X}, \tag{10}$$

where $\bar{X}$ is the total budget set for the agent. This private consumption may include spending on private goods, or spending on services other than those provided by the agent.

The agent's private consumption is

$$m_A = \bar{X} - p_1 x_1 - p_2 x_2, \tag{11}$$

where p_1 is the marginal cost of providing service 1, and p_2 is defined analogously.

4.1 First-best allocation

The first-best allocation for the principal, denoted by (x_1^P, x_2^P), is obtained by maximizing the principal's utility (9) subject to $p_1 x_1 + p_2 x_2 \leq \bar{Y}$. The associated first-order conditions are

$$\frac{\alpha_P}{p_1} v'(x_1^P) = \frac{1-\alpha_P}{p_2} v'(x_2^P) = 1, \qquad p_1 x_1^P + p_2 x_2^P < \bar{Y}; \tag{12}$$

$$\frac{\alpha_P}{p_1} v'(x_1^P) = \frac{1-\alpha_P}{p_2} v'(x_2^P) \geq 1, \qquad p_1 x_1^P + p_2 x_2^P = \bar{Y}. \tag{13}$$

4.2 Delegation

The principal sets the total budget $\bar{X}$, delegating to the agent the allocation of it between two services. Delegation can appear for several reasons, including lack of time or skill by the principal to provide the services. Or the agent may be better informed than the principal about local fiscal needs.

4.2.1 Perfect information

Consider first behavior under perfect information: the principal knows the agent's preferences (captured by α_A) and knows the costs of providing different services, given by (p_1, p_2). The timing of the game is as follows.

1. The principal sets the budget, $\bar{X}$.
2. The agent allocates the budget for private consumption and for the two services, as (x_1, x_2).

Note that the principal's choice works as a fiscal cap on the agent's decision. We will explore the subgame perfect equilibrium by examining the game backwards.

In stage 2, the agent allocates the fixed amount $\bar{X}$ among service 1, service 2, and his own consumption to maximize his utility (9). Given $\bar{X}$, his best response is

$$\frac{\alpha_A}{p_1} v'(x_1) = \frac{1-\alpha_A}{p_2} v'(x_2) = 1, \qquad p_1 x_1 + p_2 x_2 < \bar{X}; \tag{14}$$

$$\frac{\alpha_A}{p_1} v'(x_1) = \frac{1-\alpha_A}{p_2} v'(x_2) \geq 1, \qquad p_1 x_1 + p_2 x_2 = \bar{X}. \tag{15}$$

In stage 1, the principal sets a budget, anticipating the agent's responses given by (14) and (15). The principal's objective is to

$$\max_{\bar{X}} \alpha_p v(x_1) + (1-\alpha_P) v(x_2) + \bar{Y} - \bar{X}, \tag{16}$$

subject to

$$\begin{aligned}
(x_1, x_2) &= \text{argmax}_{(z_1,z_2)} \ \alpha_A v(z_1) + (1-\alpha_A) v(z_2) + \bar{X} - p_1 z_1 - p_2 z_2; & (17)\\
\bar{Y} &\geq \bar{X}; & (18)\\
\bar{X} &\geq p_1 x_1 + p_2 x_2. & (19)
\end{aligned}$$

Note that (17) is the participation constraint for the agent. The principal's budget constraint is (18); the agent's budget constraint is (19).

Anticipating the agent's response, the principal chooses $\bar{X}$. If he gives a sufficiently large budget for the agent to choose the quantities of the two services without binding the agent's budget constraint (19), the principal's utility declines with the size of the budget—a smaller budget allows the principal to increase spending, m_P, on services other than those the agent provides. The principal should therefore make the agent's budget constraint (19) bind. Then the agent's response in the neighborhood of the equilibrium strategy is derived by using (15) as

$$\begin{aligned}
0 < \frac{\partial(p_1 x_1)}{\partial \bar{X}} &= 1 - \frac{\partial(p_2 x_2)}{\partial \bar{X}} = \frac{p_1^2 (1-\alpha_A) v''(x_2)}{p_2^2 \alpha_A v''(x_1) + p_1^2 (1-\alpha_A) v''(x_2)}\\
&= \frac{1}{\left(\frac{p_2}{p_1}\right)^2 \frac{\alpha_A}{1-\alpha_A} \frac{v''(x_1)}{v''(x_2)} + 1} < 1. \qquad (20)
\end{aligned}$$

In (20), when $v''' > 0$ and the agent with a high α_A spends more on service 1, the absolute value of $v''(x_1)$ is smaller than the absolute value of $v''(x_2)$, and hence some of an increased budget will still be spent on service 1. Alternatively, when α_A is large and $v''' < 0$, little of an increased budget will be spent on service 1 .

Therefore, with (20), the associated first-order condition for the principal is

$$\begin{aligned}
&\frac{\partial(p_1 x_1)}{\partial X} \frac{\alpha_P}{p_1} v'(x_1) + \frac{\partial(p_2 x_2)}{\partial X} \frac{1-\alpha_P}{p_2} v'(x_2)\\
= \ &\frac{1-\alpha_P}{p_2} v'(x_2) + \frac{\partial(p_1 x_1)}{\partial \bar{X}} \left[\frac{\alpha_P}{p_1} v'(x_1) - \frac{1-\alpha_P}{p_2} v'(x_2) \right] \geq 1. \qquad (21)
\end{aligned}$$

Thus, if the principal has a large endowment $\bar{Y}$, the marginal benefit from the agent's increased provision of the two services induced by a larger budget equals the marginal cost of reduced consumption of services not provided by the agent. If $\alpha_P = \alpha_A$, that is if the agent's preferences for services are the same as the principal's, the first-best allocation is realized in equilibrium. Otherwise, the principal would suffer an efficiency loss arising from delegation.

Without loss of generality, let $\alpha_P > 1/2$, so that the principal prefers service 1 over service 2. Also let $p_1 = p_2 = 1$. For a given budget, the principal would want

more spending on service 1. Define $\bar{X}^* = x_1^P + x_2^P$ where (x_1^P, x_2^P), $x_1^P > x_2^P$, is given by (12) and (13). The budget $\bar{X}^*$ corresponds to the budget the principal would give the agent when their preferences were the same. We are interested in whether the equilibrium budget is larger or smaller than $\bar{X}^*$ when their preferences differ. As shown later, it depends on the utility functions. For instance, suppose $v''' > 0$. Then, as already mentioned, an increase in the budget is expected to be allocated between the two services in a balanced way.

Suppose that $\alpha_A < \alpha_P$, or that the agent's preferences for service 1 are weaker than the principal's. Consider first outcomes when their preferences do not greatly differ. Define $\mu = \frac{\alpha_P}{p_1} v(x_1^P) = \frac{1-\alpha_P}{p_2} v(x_2^P)$ in (12) and (13). Represent it by dotted horizontal lines in Figure 6. For a given budget $\bar{X}^*$, the agent will allocate it as (x_1, x_2) such that $x_2^P < x_2 < x_1 < x_1^P$, as illustrated in Figure 6. The principal's benefit from marginally increasing the budget is given by the weighted sum of $\frac{\alpha_P}{p_1} v'(x_1)$ and $\frac{1-\alpha_P}{p_2} v'(x_2)$ in (21) that are given by two bold vertical lines in Figure 6. That benefit from the marginal increase in the budget can be smaller than the weighted sum of $\frac{\alpha_P}{p_1} v'(x_1^P)$ and $\frac{1-\alpha_P}{p_2} v'\left(x_2^P\right)$, which equals μ, since the function v' is strictly convex under the assumption that $v''' > 0$. Comparing this marginal benefit to the marginal cost of increasing the budget (that is, reducing consumption of other services), the principal would choose a budget smaller than $\bar{X}^*$.

When the divergence in their preferences is sufficiently large, the principal may anticipate the allocation of $\bar{X}^*$ by the agent, as shown in Figure 6. The agent's parameter value α_A is sufficiently small so that the agent spends more on service 2 than on service 1. With a sufficiently large endowment $\bar{Y}$, the principal will then give the agent a budget larger than $\bar{X}^*$, since the weighted sum of $\frac{\alpha_P}{p_1} v'(x_1)$ and $\frac{1-\alpha_P}{p_2} v'(x_2)$ given by two bold vertical lines may be greater than μ.

Figure 6 shows outcomes when $\alpha_A > \alpha_P$. With $v''' > 0$, the weighted sum of the marginal benefit from increased spending on service 1 and service 2 exceeds its marginal cost, and the principal may choose a budget larger than $\bar{X}^*$.

Intuitively, a divergence in preferences between the principal and the agent has two, opposing, effects. First, the agent will spend some of the budget on the service the principal little values. That effect induces the principal to give a small budget. Second, the agent will spend little of the budget on the service the principal highly values. That effect would induce the principal to increase the budget he gives the agent, to induce the agent to provide more of the service the principal values.

The results are summarized as follows:

1. When the preferences of the principal and the agent differ, but not greatly, the principal may choose a budget that is smaller than in the first-best solution.

2. When the preferences of the principal and the agent differ, and the divergence is sufficiently large, or the agent's preferences are extreme, the principal may choose a budget that is larger than in the first-best solution.

If $v''' < 0$, the results may be reversed. The principal may give the agent a large budget when the agent's preferences are close to his. If the agent has extreme preferences, the principal may give the agent a small budget.

4.2.2 Imperfect information about the agent's preferences

We now turn to considering a principal who is unsure about the agent's preferences. Consider two periods. We are interested in the agent's strategic behavior in period 1 to affect the principal's beliefs, and thus the budget in period 2.

Suppose that α_A can take one of two values, α_H or α_L, with $\alpha_L < 1/2 < \alpha_H < \alpha_P$. The prior probability that $\alpha_A = \alpha_L$ is π_L. Building on the results derived in Section 4.2.1, suppose that α_L is sufficiently small to induce the principal to choose $\bar{X}^L > \bar{X}^*$ under perfect information; α_H is sufficiently close to α_P to induce the principal to choose $\bar{X}^H < \bar{X}^*$. A larger budget benefits the agent, so that the agent may be motivated to behave as if his preferences were given by α_L when his preferences are given by α_H.

The timing is as follows. In period 1:

1. Nature determines α_A.
2. The principal sets the budget $\bar{X}_1$.
3. The agent allocates the budget between the two services as (x_{11}, x_{12}).

In period 2:

1. The principal updates his beliefs about the agent's type.
2. The principal sets a new budget $\bar{X}_2$.
3. The agent allocates the budget between the two services as (x_{21}, x_{22}).

Introducing asymmetric information between the principal and the agent, we explore perfect Bayesian equilibrium.

Because any manipulation is useless at the final stage of the game, in the last stage of period 2 the agent spends the budget $\bar{X}_2$ according to his preferences, that is, according to (15). Denote a type-k agent's choice of (x_{t1}, x_{t2}) that maximizes his one-period utility (9) according to (15) given $\bar{X}_t$ by $(x_{t1}^k(\bar{X}_t), x_{t2}^k(\bar{X}_t))$, $t = 1, 2$, $k = H, L$. Thus $x_{ti}^k(\bar{X}_t)$ corresponds to the agent's choice in the absence of signaling considerations. Figure 6 displays choices by the two types of agents, when each faces a budget $\bar{X}_t$: the marginal rate of substitution equals the ratio of the marginal costs for providing the two services. For any pair of services (x_{t1}, x_{t2}), each type's marginal rate of substitution satisfies the following single-crossing property:

$$\frac{\alpha_L v'(x_{t1})}{(1-\alpha_L)v'(x_{t2})} < \frac{\alpha_H v'(x_{t1})}{(1-\alpha_H)v'(x_{t2})}. \tag{22}$$

In the second penultimate stage in period 2, the principal sets the budget for period 2. When he has the posterior beliefs such that $\tilde{\pi}_L = 1$, he will give the agent $\bar{X}^L$, which exceeds $\bar{X}^*$. On the other hand, when he infers that $\tilde{\pi}_L = 0$, he will give the agent the budget $\bar{X}^H < \bar{X}^*$. If the principal is unsure of the agent's type, with the posterior beliefs the same as the prior beliefs, he will give the agent the budget $\bar{X}^{\pi_L}$, such that $\bar{X}^H < \bar{X}^{\pi_L} < \bar{X}^L$. In period 1 the agent thus has an incentive to behave strategically, influencing the principal's beliefs: given a larger budget, the agent can spend more on each service according to (20), and may increase his utility.

We will then examine behavior by each type of agent in period 1, where the agent's choice of x_{11} and x_{12} affects the principal's beliefs about the agent's type. Let $*$ denote the equilibrium choice of the agent with his signaling considerations.

We first examine the agent's choice in period 1 in a separating equilibrium satisfying $(x_{11}^{L*}, x_{12}^{L*}) \neq (x_{11}^{H*}, x_{12}^{H*})$, $\tilde{\pi}_L(x_{11}^{L*}, x_{12}^{L*}) = 1$, and $\tilde{\pi}_L(x_{11}^{H*}, x_{12}^{H*}) = 0$, where the agent reveals his type. Given $\tilde{\pi}_L(x_{11}^{H*}, x_{12}^{H*}) = 0$, a type-$H$ agent should choose $(x_{11}^{H*}, x_{12}^{H*}) = (x_{11}^{H}(\bar{X}_1), x_{12}^{H}(\bar{X}_1))$ in equilibrium. We assume that the principal's beliefs at the decision nodes in the information set off the equilibrium path are such that $\tilde{\pi}_L(x_{11}, x_{12}) = 0$ for $(x_{11}, x_{12}) \neq (x_{11}^{L*}, x_{12}^{L*})$. Then the necessary conditions for a separating equilibrium are[2]

$$\begin{aligned} & \left[\alpha_L v(x_{11}^{L*}) + (1-\alpha_L) v(x_{12}^{L*})\right] \\ & + \left[\alpha_L v(x_{21}^{L}(\bar{X}^L)) + (1-\alpha_L) v(x_{22}^{L}(\bar{X}^L))\right] \\ \geq \; & \left[\alpha_L v(x_{11}^{L}(\bar{X}_1)) + (1-\alpha_L) v(x_{12}^{L}(\bar{X}_1))\right] \\ & + \left[\alpha_L v(x_{21}^{L}(\bar{X}^H)) + (1-\alpha_L) v(x_{22}^{L}(\bar{X}^H))\right]; \end{aligned} \tag{23}$$

$$\begin{aligned} & \left[\alpha_H v(x_{11}^{L*}) + (1-\alpha_H) v(x_{12}^{L*})\right] \\ & + \left[\alpha_H v(x_{21}^{H}(\bar{X}^L)) + (1-\alpha_H) v(x_{22}^{H}(\bar{X}^L))\right] \\ \leq \; & \left[\alpha_H v(x_{11}^{H}(\bar{X}_1)) + (1-\alpha_H) v(x_{12}^{H}(\bar{X}_1))\right] \\ & + \left[\alpha_H v(x_{21}^{H}(\bar{X}^H)) + (1-\alpha_H) v(x_{22}^{H}(\bar{X}^H))\right]. \end{aligned} \tag{24}$$

In a separating equilibrium, a type-L agent allocates his budget in a way that a type-H agent would not want to mimic. Then a type-H agent chooses $(x_{11}^{H}(\bar{X}_1), x_{12}^{H}(\bar{X}_1))$ that maximizes his utility in period 1 but reveals his type; he cannot get a larger budget in period 2. Note that $(x_{11}^{L*}, x_{12}^{L*})$ does not always coincide with $(x_{11}^{L}(X_1), x_{12}^{L}(X_1))$. A type-$L$ agent separates himself from a type-H agent by choosing the allocation that makes a type-H agent worse off by mimicking even if he can get a large benefit in period 2. Such an allocation may induce a type-L agent to spend more on service 2 than he would in the absence of signaling considerations.

Anticipating the agent's subsequent behavior, in the second penultimate stage in period 1, the principal sets a budget. His choice should induce a type-H agent to reveal his type, so that the following condition should hold:

$$\begin{aligned} & \left[\alpha_H v(x_{11}^{L*}) + (1-\alpha_H) v(x_{12}^{L*})\right] \\ & + \left[\alpha_H v(x_{21}^{H}(\bar{X}^L)) + (1-\alpha_H) v(x_{22}^{H}(\bar{X}^L))\right] \\ = \; & \left[\alpha_H v(x_{11}^{H}(\bar{X}_1)) + (1-\alpha_H) v(x_{12}^{H}(\bar{X}_1))\right] \\ & + \left[\alpha_H v(x_{21}^{H}(\bar{X}^H)) + (1-\alpha_H) v(x_{22}^{H}(\bar{X}^H))\right]. \end{aligned} \tag{25}$$

The second term on the left-hand side is greater than that on the right-hand side in (25), because the agent gets a larger budget. For (25) to be satisfied, the first term on the right-hand side should be larger than that on the left-hand side.

Moreover, $((x_{11}^{L*}, x_{12}^{L*}), (x_{11}^{H*}, x_{12}^{H*}))$ satisfying $(x_{11}^{L*}, x_{12}^{L*}) = (x_{11}^{H*}, x_{12}^{H*})$, given $\tilde{\pi}_L(x_{11}^{L*}, x_{12}^{L*}) = \pi_L$ and $\tilde{\pi}_L(x_{11}, x_{12}) = 0$ for any $(x_{11}, x_{12}) \neq (x_{11}^{L*}, x_{12}^{L*})$, constitutes a pooling equilibrium

[2] It follows from the discussion in Section 4.2.1 that $m_A = 0$ should hold in equilibrium.

if a type-H agent benefits most from spending in a way that makes him indistinguishable from a type-L agent. That condition is

$$\begin{aligned} & \left[\alpha_L v(x_{11}^{L*}) + (1-\alpha_L) v(x_{12}^{L*})\right] \\ & + \left[\alpha_L v(x_{21}^{L}(\bar{X}^{\pi_L})) + (1-\alpha_L) v(x_{22}^{L}(\bar{X}^{\pi_L}))\right] \\ \geq \quad & \left[\alpha_L v(x_{11}^{L}(\bar{X}_1)) + (1-\alpha_L) v(x_{12}^{L}(\bar{X}_1))\right] \\ & + \left[\alpha_L v(x_{21}^{L}(\bar{X}^{H})) + (1-\alpha_L) v(x_{22}^{L}(\bar{X}^{H}))\right]; \end{aligned} \tag{26}$$

$$\begin{aligned} & \left[\alpha_H v(x_{11}^{L*}) + (1-\alpha_H) v(x_{12}^{L*})\right] \\ & + \left[\alpha_H v(x_{21}^{H}(\bar{X}^{\pi_L})) + (1-\alpha_H) v(x_{22}^{H}(\bar{X}^{\pi_L}))\right] \\ \geq \quad & \left[\alpha_H v(x_{11}^{H}(\bar{X}_1)) + (1-\alpha_H) v(x_{12}^{H}(\bar{X}_1))\right] \\ & + \left[\alpha_H v(x_{21}^{H}(\bar{X}^{H})) + (1-\alpha_H) v(x_{22}^{H}(\bar{X}^{H}))\right]. \end{aligned} \tag{27}$$

For example,

$$(x_{11}^{L*}, x_{12}^{L*}) = (x_{11}^{H*}, x_{12}^{H*}) = (x_{11}^{L}(\bar{X}_1), x_{12}^{L}(\bar{X}_1)), \tag{28}$$

may constitute a pooling equilibrium. Figures 6 and 6 describe intertemporal choices by a type-H agent in this pooling equilibrium. In period 1, a type-H agent gets lower utility by mimicking than by not. In period 2, however, his loss by mimicking is compensated for by getting a larger budget $\bar{X}^L$ rather than $\bar{X}^H$.

In this pooling equilibrium, the principal's choice in the second penultimate stage in period 1 must satisfy the incentive compatibility constraint for a type-H agent in (27). The second term on the left-hand side in (27) exceeds that on the right-hand side because a larger budget is given to the agent. The principal's optimal choice of $\bar{X}_1$ depends on the details of the model, but comparing (25) to (27) shows that it may be easier for the principal to induce a pooling equilibrium rather than a separating one, as already mentioned in Section 3. In a separating equilibrium, in period 2 (after the agent allocates his spending in period 1), a type-H agent whose preferences are close to the principal's gets a smaller budget $\bar{X}^H$. In contrast, a type-L agent whose preferences greatly differ from the principal's gets a larger budget $\bar{X}^L$.

Alternatively, if $1/2 < \alpha_L < \alpha_H < \alpha_P$, the results may be similar to the results derived in Section 3: under perfect information, an agent gets a larger budget the closer his preferences are to the principal's preferences; an agent whose preferences differ greatly from the principal's may gain a large budget in period 2 by manipulation in period 1.

4.3 Extensions

4.3.1 Imperfect information about the costs of services

Next consider asymmetric information about the marginal cost of a service. Let $p_1 = 1$. Moreover let p_2 take one of two values p_L or p_H such that $p_L < p_H$, with some exogenous prior probability q_L that $p_2 = p_L$. The agent knows which value has occurred, but

the principal cannot observe it. Let us consider a two-period model, with asymmetric information about the marginal cost of service 2. The agent, by manipulating the information on the cost of service 2 in period 1, may get a large budget in period 2.

Suppose that p_L and p_H satisfy the following relationship.

$$\frac{p_H\alpha_P}{1-\alpha_P+p_H\alpha_P} > \frac{p_L\alpha_P}{1-\alpha_P+p_L\alpha_P} > \frac{p_H\alpha_A}{1-\alpha_A+p_H\alpha_A} > 1/2 > \frac{p_L\alpha_A}{1-\alpha_A+p_L\alpha_A}. \quad (29)$$

This inequality implies that the principal wants to spend more on service 1 even if the marginal cost of service 2 is low; on the other hand, the agent values service 1 less than does the principal, so that when the marginal cost for providing service 2 is low, he wants to spend more on service 2. Under the supposition (29), the previous argument about the agent's signaling behavior and the principal's choice of a budget can be used.

In the final stage in period 2, the agent sincerely spends a budget given by the principal, according to (15). The agent will be better off if he gets a larger budget in that period. In the second penultimate stage in period 2, the principal sets a budget for the period given his posterior beliefs about p_2. With $\tilde{q}_L = 0$, he expects that the agent spends more on service 1 than service 2, but less than the principal would prefer. Therefore, the principal will give a smaller budget than in the first-best solution for the principal. If the principal infers that $\tilde{q}_L = 1$, he may set a larger budget than in the first-best solution, to induce the agent to spend enough on service 1. Such behavior by the principal may induce the agent to behave strategically in period 1, in order to influence the principal's beliefs.

We can examine the agent's strategy in period 1 in the same manner as in Section 4.2.2. In a separating equilibrium, the agent truthfully reveals p_2 to the principal. In a pooling equilibrium, the agent behaves as if $p_2 = p_L$ when $p_2 = p_H$ in fact. Thus, in a pooling equilibrium, the agent pretends to face a low marginal cost of the service that the principal prefers less, and induces the principal to give a larger budget. Such behavior produces inefficiency.

4.3.2 Imperfect information about each other's preferences

Now suppose that the principal and the agent do not know the preferences of each other. Suppose further that the principal's preference parameter α_P takes one of two values α_L and α_H as for the agent, and that these two values do not greatly differ. If the agent knows the principal's type, he can get a larger budget by pretending to have the same preferences as the principal, even when that is false. We are interested in the agent's behavior when he is uncertain about the principal's type.

In the final stage in period 1, if the principal's preference parameter $\alpha_P = \alpha_L$ was perfectly revealed by his choice of budget in that period, the subsequent choice by the agent in period 1 would constitute a separating or pooling equilibrium. In a pooling equilibrium, a type-H agent would pretend to be type L, to gain a larger budget. If the principal's choice of budget revealed his preference parameter to be $\alpha_P = \alpha_H$, a type-H agent may no longer pretend to be of type L, because he would get a smaller budget in period 2 by this manipulation than he would gain without manipulation. If the principal takes the inefficiency produced by the agent's strategic manipulation seriously, in the first period, the principal may randomize his choice of budget. In equilibrium, with

the principal's type incompletely revealed, the agent may also use a mixed strategy or reveal his type. Intuitively, an agent who is unsure about the principal's preferences finds it difficult to behave as if his preferences were identical to the principal's, and induce the principal to give him a larger budget.

We can apply the same discussion to an agent who can elicit a larger budget from the principal by pretending that his preferences differ from the principal's.

5 Fiscal problems in Japan

The models used in Section 3 and Section 4 suggest that an agent captured by special interests, taking advantage of his private information, can get a large discretionary budget that enables him to benefit the interest groups. Using the example of spending on public works, we apply our analysis to explain increased government spending and the resultant fiscal deficits in Japan.

5.1 Misreporting costs

Spending on public works is discretionary. It is well known that initial annual budgets in each fiscal year for public works in Japan have been allocated among projects for forestry and water control, roads, ports, harbors, airports, water services, waste disposal facilities, and infrastructure for agriculture at a stable ratio; see Figure 7 and Figure 8.[3] In Figure 7, spending appears to have changed in a similar manner for almost all categories. Figure 8, which displays the annual growth rate of spending in each category in the initial annual budget, supports this idea. This phenomenon, which should be observed when the principal gives the agent discretion in spending across different public projects, has been said to occur because the government departments in charge (*the agents*) were pressured by local interest groups, local governments, and politicians elected in the jurisdictions that will benefit from those projects if implemented. See Figure 6, which shows the principal-agent relationship in the budget process for spending on public works, and the influences on the agent from the vested interests.

Japan has a parliamentary system, with the political parties controlling a majority of the seats in the House of Representatives of the Diet forming the government. The central government's budget, prepared by the Ministry of Finance and submitted to the Diet, has usually won legislative approval without major conflicts between the government and the Diet. Therefore, negotiations between the Ministry of Finance and each spending ministry, which is also a constituent of the government, prior to the submission to the Diet have been important in the budget process.

Since 1955, except for a few recent years, the Liberal Democratic Party (the LDP) has formed the government of Japan. It has been frequently pointed out that factionalism in the LDP may have caused common-pool problems. Diet members belonging to a faction are connected to special interests and attempt to get large budgets for policies that benefit them. In combination with vested interests, they may misreport costs of

[3]We used the data until 2000 because the definition of some categories changed after that fiscal year. We excluded two categories because: one was subject to changes of definition during the period from 1985 to 1999, and the other is miscellaneous.

public works. Moreover, corruption, which can influence decision-making in favor of those groups, may hide information about costs.

Some important public projects were more expensive than initially planned, and were criticized as inefficient and wasteful after completion. One example is Kansai International Airport. To avoid noise pollution, the airport is built on an artificial island in the middle of Osaka Bay in Osaka Prefecture. Its construction was planned in the 1960s, anticipating increased demand for air services. Construction started in the 1980s. In the course of construction, mis-estimation of costs was revealed. The artificial island sunk much more than predicted, because of soft soils in Osaka Bay. Additional spending was needed for adjustments. Moreover, the airport was debt-financed. It had to expend further funds on unanticipated interest payments because completion was delayed. Compensation to local fisheries also exceeded the initial estimate. Thus the project became more expensive as it went on. The airport was opened in 1994, but as of FY2013, it still receives subsidies from the central government for stable management.[4]

To address the problems of misreporting by the agent, costs of public works should be estimated more precisely and inspected more carefully. Using the information on other projects or on other agents' behavior as a yardstick may be helpful. The principal can allocate a budget to an agent depending not only on the agent's choices but also on any other observation available. Indeed, the principal can use these observations as a yardstick when updating his beliefs (i.e., calculating $\tilde{q}_L$ in Section 4.3.1). Recall that the agent manipulates information in order to get a large budget later. If the agent knows that the principal is less likely to be cheated, cheating may be less attractive for the agent.

Also, to obtain information about the value of the project, the government can hold a public auction or collect private funds, for example by issuing revenue bonds. Thus, acquiring much information enables the principal to induce agents to compete. These measures can reduce inefficiency produced by delegation and asymmetric information.

5.2 Uncertainty about the agents' preferences

In the budget process in Japan, the principal can be considered as the prime minister or as the Ministry of Finance, as described in Figure 6. The agents may be considered as spending ministries or local governments. The principal may be unsure about the preferences of different ministers. Such uncertainty about preferences is especially likely to occur under a new prime minister, or under new ministers, or in a coalition government where ministers do not necessarily share the prime minister's preferences. The coalition need not be a formal one, but can be an effective one, as with the LDP in Japan. Referring to our analysis in Section 4.2.2, which examined the effect of uncertainty about the agents' preferences, the total budget may be large under a new administration.

In 2009, after the victory in the House of Representatives election, the Democratic Party of Japan formed the new government in place of the LDP. Figure 10 shows the annual growth rate of the total annual initial budget, as well as budgets for major policy

[4] We thank Nobuo Akai and Takero Doi for this example.

fields.[5] In the FY2010 budget, which was drawn up for the first time by the new government, spending for redistributive purposes, including social security spending, and local allocation tax grants, greatly increased.[6]

Moreover, spending shifted from public works to education and science, as the Democratic Party of Japan promised in the campaign. Despite a large decline in spending on public works, total spending net of debt-servicing costs, which is plotted in the bold curve, rose, as our model predicts. The Democratic Party of Japan was in charge of drawing up budgets for FY2010, FY2011, and FY2012. The budget gradually declined, perhaps reflecting the resolution of uncertainty.

5.3 Supplementary budgets

The Japanese government, after adopting an initial annual budget, often later adopts a supplementary budget. In terms of our model, we can think of the initial budget as the budget in period 1, and the supplementary budget as the budget in period 2. Figure 11 shows the change in spending for public works included in the initial annual budget and the supplementary budget of each fiscal year.[7] One reason for increased supplementary budgets in the 1990s is that the government used supplementary budgets for public works in economic stimulus packages to address the economic downturn in that period; inefficient spending may also have favored vested interests. The Japanese government has attempted to limit the size of the initial budget by setting a fiscal cap on discretionary spending included in it. But the supplementary budget has been free from fiscal restraint. Even if the government adopted a reasonably balanced budget at first, added budgets enlarged the deficit. The puzzle is why the supplementary budget allowed great spending.

Figure 12 shows by category the ratio of spending on public works in the supplementary budget to such spending in the initial annual budget. Almost all time-series, except spending for maintenance and improvement of housing and urban environment, move in a similar way. The data thus suggest that agencies have discretion in spending on public works, even in the emergency economic stimulus packages. The measures we examined in Section 5.1 to address the problems of misreporting by the agent can also be used when considering modifications of the budget. Fiscal restraint on the supplementary budget using the results of inspection can reduce inefficient government spending.

Those measures can be also applied to the medium-term fiscal plan. In Japan, the government creates a medium-term fiscal plan, but it cannot bind spending. The government may induce the agent to spend according to the plan by monitoring his annual spending and using results from monitoring in setting a budget for the next year.

We can see, by returning to Figure 10, that spending on public works rose in the initial FY2013 budget, drawn up by the revived LDP government. We have to be careful again in monitoring spending on public works.

[5] The budgets for FY2009 were large, to address the effects of the Lehman shock.

[6] The new administration abolished fiscal caps in drawing up the FY2010 budget. It motivated each spending ministry to require increased budgets. Accordingly, fiscal caps were restored next year.

[7] Spending for post-disaster recovery projects is excluded.

6 Conclusion

In many democracies, whether at the central or local level, decisions about the budget and spending are divided among multiple persons or departments. We can regard a person or a group setting a budget as a principal who delegates the allocation of the budget to the agent. This principal-agent relationship may distort the principal's decision on the size of a budget when their preferences diverge, since the principal must set a budget anticipating the agent's response.

First we examined inefficiency caused by delegation under the assumption of perfect information. In equilibrium, the budget may be lower or higher than in the first-best solution, depending on how the marginal utility from each service declines as the quantity of a service increases. Then we developed a two-period model where the agent's spending on each service in period 1 signals his own preferences or the marginal cost of providing a service to the principal, and affects the principal's decision on a budget in period 2.

A separating or pooling equilibrium may occur. In a pooling equilibrium, the agent is driven by strategic considerations to gain a large budget in the following period. In a separating equilibrium, the agent reports truthfully, allowing the principal to set an optimal budget for each type in the following period. In the separating equilibrium, however, the agent may have to be given a sufficiently large budget in period 1 so that he would not demand a large budget in period 2. If the principal adopts some measures to elicit information, the expected benefit from cheating is reduced; the agent may be induced to tell truth with a smaller budget in period 1. Thus inefficiency may be reduced by reforms of the budgetary process.

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Notation

p_i Marginal cost of service i

$v(\cdot)$ Utility from consumption of a service

$\bar{X}$ Budget set by the principal

x_i Quantity of service i provided

x_{ti}^k Choice of service i in period t by a type-k agent in the absence of signaling considerations

x_{ti}^{k*} Optimal choice of service i in period t by an agent of type k when signaling considerations are present

x_i^P first-best allocation for the principal of service i

$\bar{X}^*$ first-best level of the budget which the principal would give the agent when their preferences are the same

$\bar{Y}$ Principal's endowment in each period

α_A Parameter describing preferences of the agent

α_P Parameter describing preferences of the principal

π_L Prior probability that $\alpha_A = \alpha_L$

$\tilde{\pi}_L$ Posterior probability that agent is of type-L, or has $\alpha_A = \alpha_L$

$\tilde{q}_L$ Posterior probability that $p_2 = p_L$

Fig. 1
Title:
Budget allocation in the first-best solution and by delegation ($\alpha_P > \frac{1}{2}$, $\alpha_A < \alpha_P$, but the divergence between α_P and α_A is not sufficiently large)

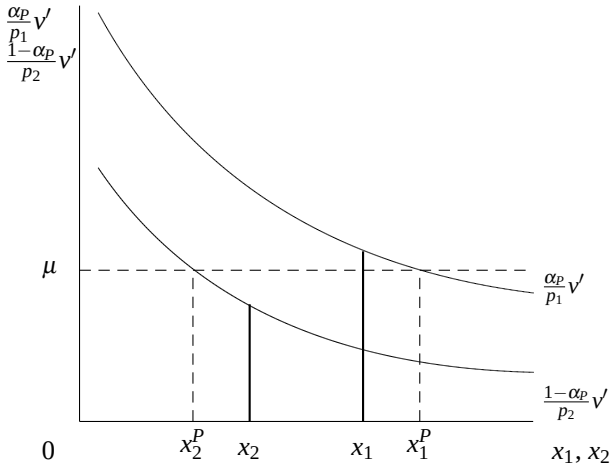

Fig. 2
Title:
Budget allocation in the first-best solution and by delegation ($\alpha_P > \frac{1}{2}$, $\alpha_A < \alpha_P$, and the divergence between α_P and α_A is sufficiently large)

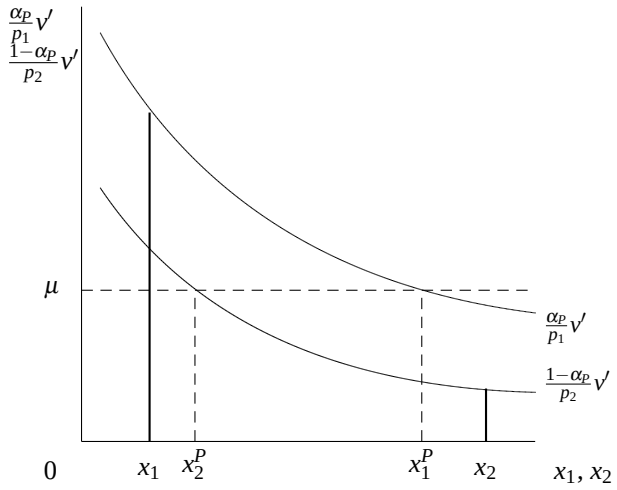

Fig. 3
Title:
Budget allocation in the first-best solution and by delegation ($\alpha_P > \frac{1}{2}$, $\alpha_A > \alpha_P$)

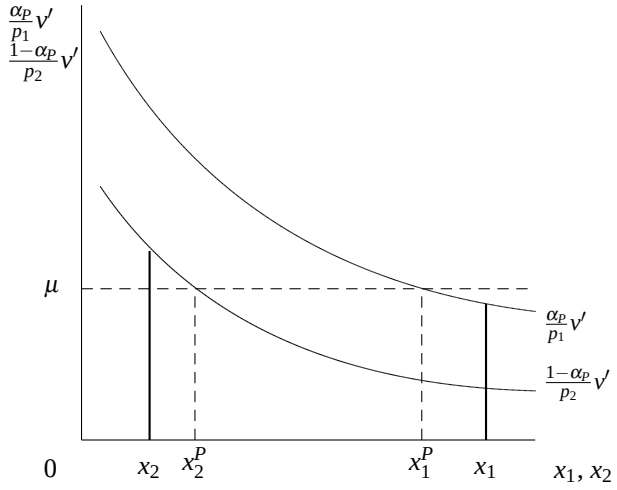

Fig. 4
Title:
Budget allocation by the agent without signaling considerations

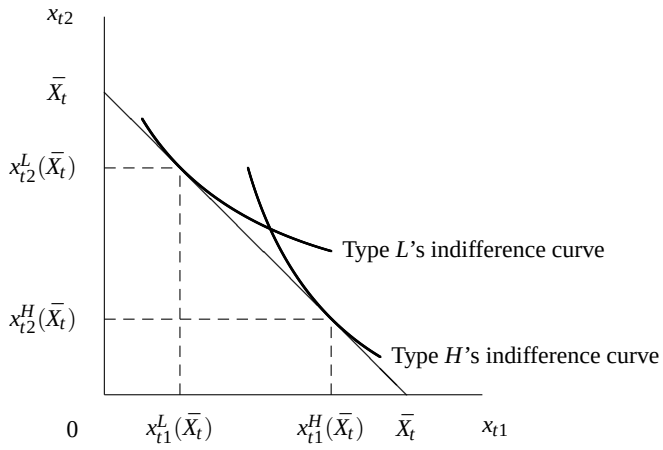

Fig. 5
Title:
Budget allocation by the agent in period 1 with signaling considerations

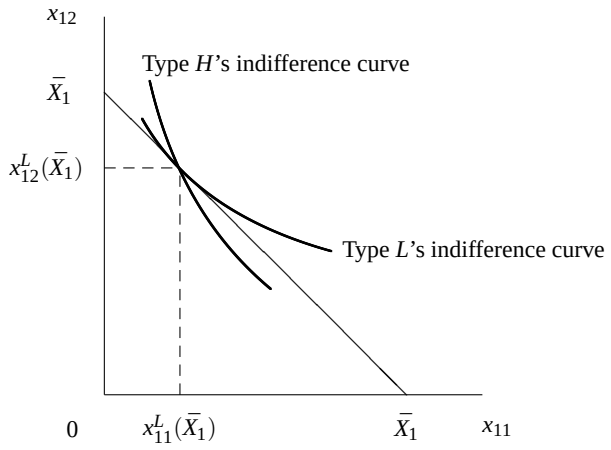

Fig. 6
Title:
Budget allocation by a type-H agent in period 2

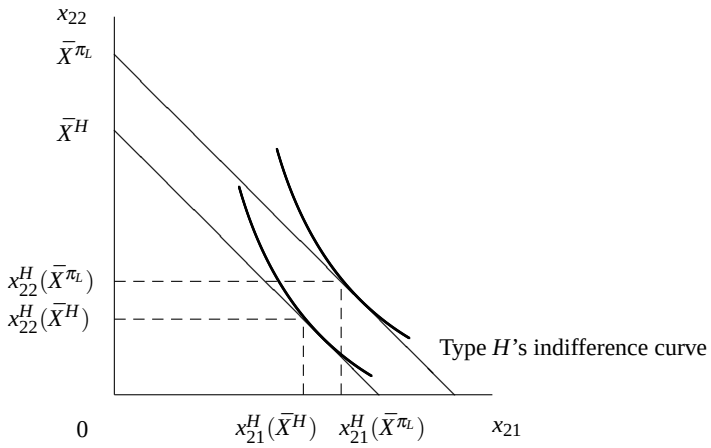

Fig. 7
Title:
Expenses in each category in the original annual budget
Data source: Ministry of Finance Japan

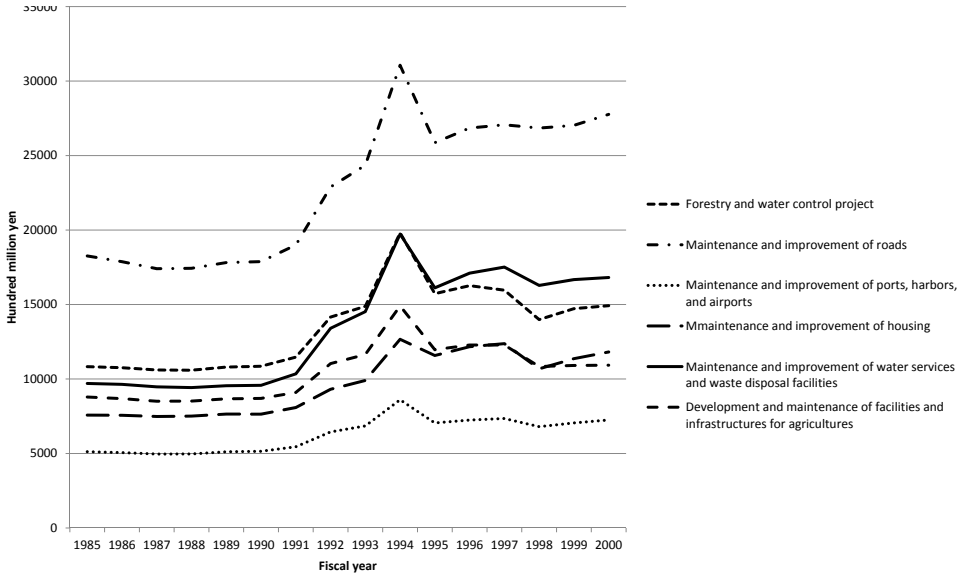

Figure 7: Expenses in each category in the original annual budget
Data source: Ministry of Finance Japan

Fig. 8
Title:
Annual growth rate of expenses in each category in the original annual budget
Data source: Ministry of Finance Japan

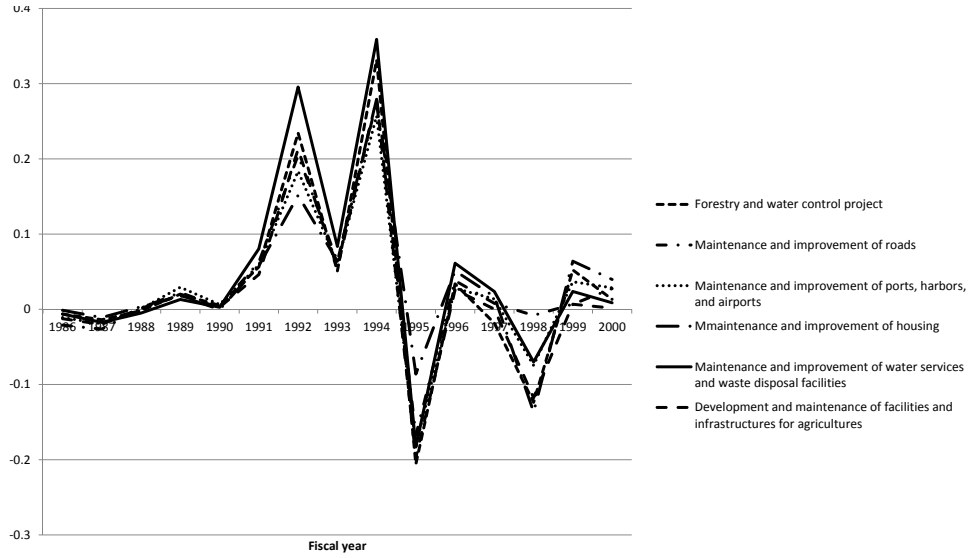

Figure 8: Annual growth rate of expenses in each category in the original annual budget
Data source: Ministry of Finance Japan

Fig. 9
Title:
Budget process for public works spending

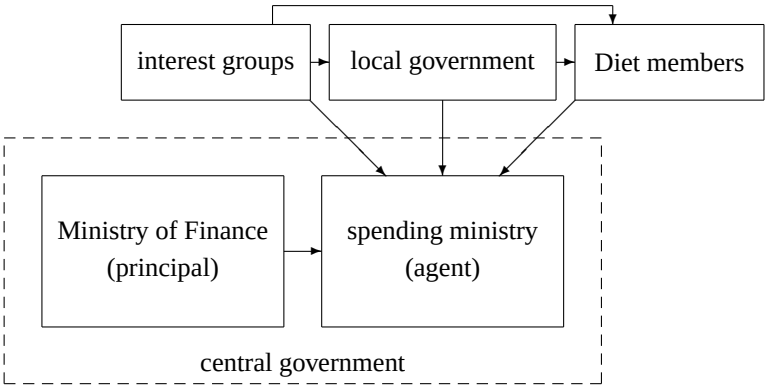

Fig. 10
Title:
Annual growth rate of expenses on major policy fields in the annual original budget
Data source: Ministry of Finance Japan

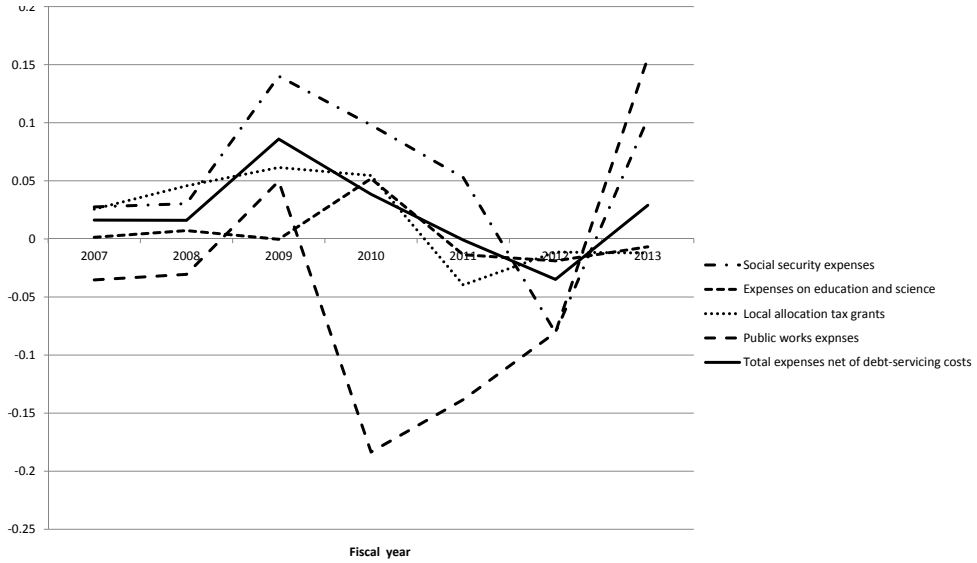

Figure 10: Annual growth rate of expenses on major policy fields in the annual original budget
Data source: Ministry of Finance Japan

Fig. 11
Title:
Expenses for public works in the original annual budget and supplementary budget
Data source: Ministry of Finance Japan

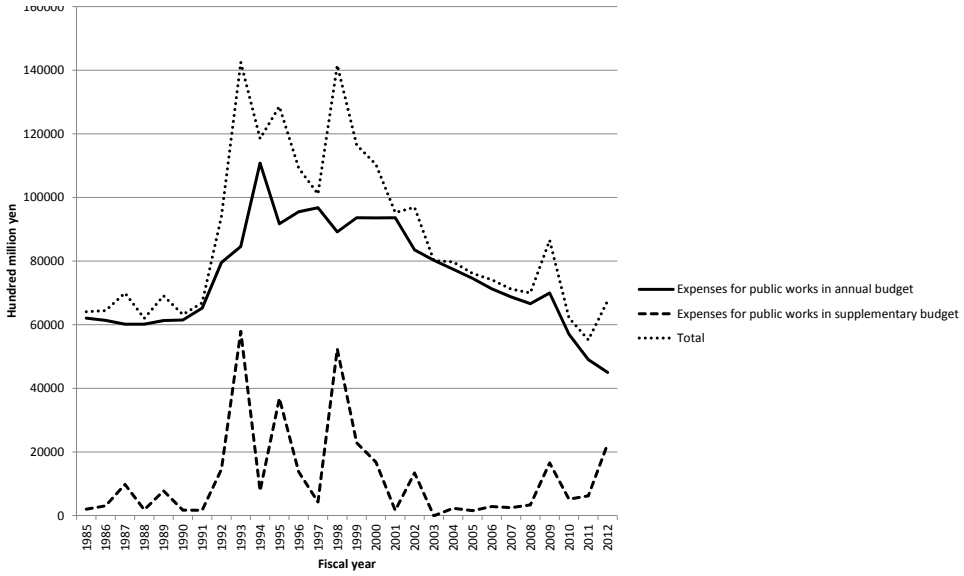

Figure 11: Expenses for public works in the original annual budget and supplementary budget
Data source: Ministry of Finance Japan

Fig. 12
Title:
The ratio of expenses in each category in the supplementary budget to those in the original annual budget
Data source: Ministry of Finance Japan

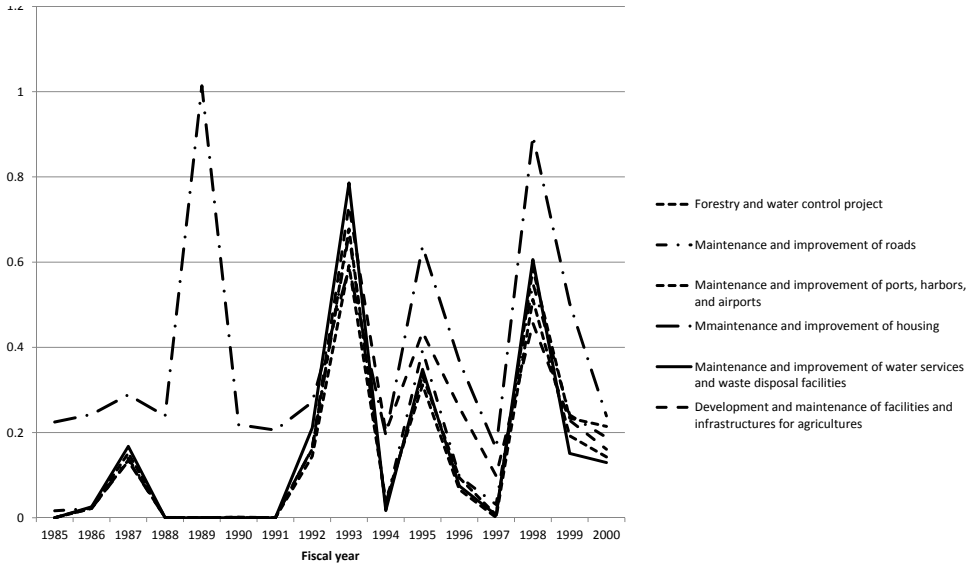

Figure 12: The ratio of expenses in each category in the supplementary budget to those in the original annual budget
Data source: Ministry of Finance Japan